STP 4-06 MODEL-BASED TECHNICAL DATA IN PROCUREMENT

3D PDF TECHNOLOGY DATA DEMONSTRATION PROJECT

PHASE I SUMMARY

REPORT DL309T2

LMI

JULY 2015

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PHASE 1 SUMMARY

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3D PDF Technical Data Demonstration

This report is an accompanying reference to our previously delivered *3D PDF Tech Data Demonstration R&D Project: Final Report*, 28 July 2015. It serves as an historical record and single-source package describing the planning efforts for the follow-on research and development (R&D) project, STP 5-L-06, “Procuring Parts Using Model-Based Technical Data–3D Demonstration Project.”

BACKGROUND

In addressing the issue of using three dimensional (3D) technical data in procurements, the Defense Logistics Agency’s (DLA’s) Weapon System Sustainment Program (WSSP) prepared a concept of operations (CONOPS) for using model-based technical data in procurement. The CONOPS outlined the following:

- Recommended a desired end-state wherein the military services would provide DLA with 3D technical data that are complete, validated, and stored in a 3D portable document format (PDF) file plus an associated Standard for the Exchange of Product Data (STEP) file (i.e., ISO 10303) to eliminate various technical, procedural, and legal challenges in the procurement process.
- Noted that DLA can take few unilateral actions to ensure it achieves the desired end-state. Most of those actions require collaboration with the engineering support activities (ESAs), military services, program manager offices, or Office of the Secretary of Defense (OSD) components. DLA needs to convince those activities that it is in the DoD’s best interest to provide technical data packages (TDPs) in a 3D PDF format with a corresponding STEP file to facilitate parts procurement.
- Suggested that the most effective way to exert such influence would be through an R&D demonstration project conducted in conjunction with two or three ESAs and DoD supply chains. The collaborative project would prove the concept of the end-to-end process of creating and using a 3D PDF file (with an associated STEP file) to solicit and manufacture parts and demonstrate the viability of this approach for the services and DoD.
- Highlighted that DLA needs to recognize when it makes sense from a financial or support perspective to modernize existing (legacy) two dimensional (2D) technical data to a 3D format.

PROJECT SUMMARY

The goal of the 3D PDF technical data demonstration (an adjunct R&D task under STP 4-06, Model-Based Technical Data in Procurement) is to help DLA move toward the use of more modern technical data in its daily procurement activities and influence DoD to adopt 3D PDF data files as a means of transferring those data. The use of modern 3D data would give DLA a more agile, more reliable, and less costly way to have parts built to support America's warfighters.

The project's objective is to assess DLA's capability to acquire Class IX parts using modern technical data recorded in a 3D PDF file with an attached STEP file. To accomplish this objective, the demonstration will exercise DLA's current procurement process to buy real parts in an operational environment. However, none of the parts purchased during this project will be used in the operational supply chain; they will be used strictly for R&D purposes. The project is designed to yield various metrics to evaluate the procurement and manufacturing process steps and document all "lessons learned" so they can inform the follow-on phases of the 3D PDF technical data demonstration, as appropriate.

Phase 1 of the project, which is the focus of this report, concentrates on establishing the groundwork and performing the planning actions for parts procurement during the follow-on phases of the 3D PDF technical data demonstration. This phase also includes an analysis of legacy technical data (i.e., 2D data), primarily to determine what data should be considered for modernization, when the data should be modernized, and what data formats should be used to modernize data. (Specific details are summarized in Appendix A.)

PROJECT DESCRIPTION

Phase 1 of the 3D PDF demonstration project concentrated on building support for the concept, understanding DLA's current procurement process, identifying any necessary changes to facilitate use of 3D data, documenting the model-based technical data development and transfer process necessary to enable the use of 3D PDF templates, identifying organizations to participate in the demonstration, defining and establishing participant roles and responsibilities, and identifying candidate parts for procurement during the next phase of the project. We expand on each of these areas in the following subsections.

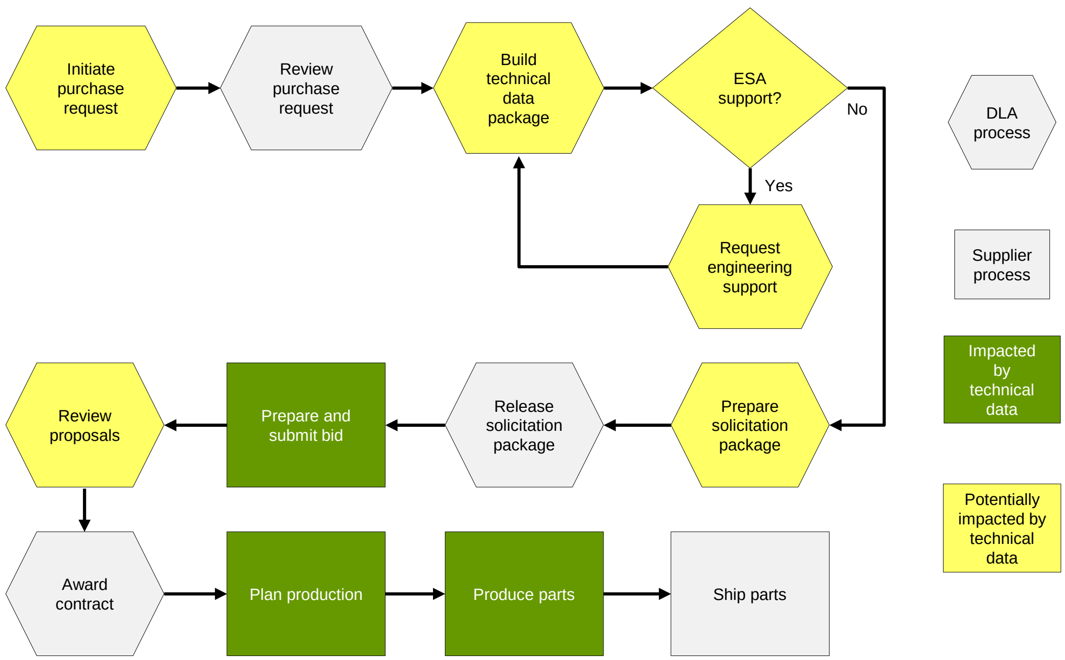
Current Procurement Process

DLA's current procurement processes require the use of validated technical data. Traditionally, those data for parts have been provided by the military services' ESAs. DLA uses a standard process for obtaining, consolidating, and making the technical data available in its procurement process.

DLA Procurement Process

Figure 1 depicts DLA's current procurement process. It identifies who (i.e., DLA or the supplier) performs each process step and whether the step is affected by the use of technical data.

Figure 1. DLA Procurement Process



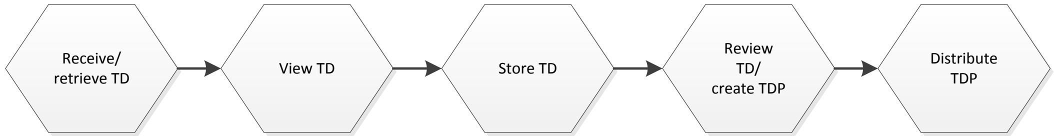
The procurement process begins when DLA determines it needs to buy a part and initiates a purchase request. DLA then builds a TDP that includes all relevant information so a supplier can build or source the part.

After the TDP is completed, DLA prepares a solicitation package and releases it to the public through the DLA Internet Bid Board System (DIBBS). Potential suppliers review the solicitation, including the TDP, and prepare quotes and proposals that are returned to DLA. DLA then reviews all of the proposal submissions and awards a contract to the winning supplier. The winning supplier uses the TDP to plan and build the part, which it subsequently ships to a designated receiving site.

Building and Distributing a TDP

Building and distributing a TDP as part of a procurement solicitation requires a series of steps. Each step is performed by personnel with different roles, principally product data specialists (PDSs) and product specialists (PSs). Figure 2 summarizes the procurement steps. This process is based on the current use of 2D technical data.

Figure 2. Building and Distributing a TDP for Procurement—DLA Steps



Note: TD = technical data.

We expand on each of these steps below:

- *Receive/retrieve TD*. Technical data are owned and provided by the military service or ESA. If DLA had previously procured a part, the technical data may already be stored in DLA's Document Management System (DMS). If the files are not in DMS, the PDSs can search the Military Engineering Data Asset Locator System (MEDALS) or the services' repositories for the appropriate documents. The PDSs use an engineering data list (EDL) for Air Force systems or a technical data package list (TDPL) for Army systems to identify and confirm the technical data files are the most current and appropriate version. The Navy only submits a high-level system document to DLA, so the PDSs must do a top-down breakdown of the system by searching through Navy data repositories to identify, find, and extract the data that best describes the part to be procured. If the PDSs cannot obtain the most current or appropriate version of the data, they engage the ESA for assistance. The technical data provided by the ESA may be submitted to DLA by email or through regular mail.

- *View TD*. The PDSs open and view the technical data to assess if it is saved in an accessible format, legible, and complete (i.e., contains all of the documents) per the EDL or TDPL. If there are any issues, the PDSs attempt to resolve them, which could include asking ESAs for help. The PDSs may need to edit the technical data to make it more legible (e.g., crop images, de-speckle or de-skew the images, or change the format).

- *Store TD*. The PDSs upload the technical data into DMS and link it to the appropriate material (i.e., part to be procured) in the Material Master File to build the bidset that will be used for the procurement solicitation.

- *Review TD*. The PSs review the technical data in the bidset to ensure it is legible and contains all the information required to manufacture or source the part DLA plans to procure. The review process ensures DLA's suppliers will have the information they need to develop a bid or quote to manufacture the part. It also ensures they have the information needed to develop a process plan, manufacture the part, and perform quality assurance checks.

- *Distribute TDP*. When the solicitation package is approved and released for procurement, the Enterprise Business System (EBS) posts the bidsets (which include the TDP) automatically to cFolders. Suppliers access and review the solicitations posted to DIBBS and use an embedded link to

view or download the associated TDP in cFolders to facilitate the bid and proposal preparation as well as manufacturing (if awarded a contract).

These process steps are repeated for every procurement or acquisition.

DLA Capability to Process 3D Tech Data

DLA's current procurement process (Figure 1) does not need to change to accommodate 3D technical data in a 3D PDF format. Similarly, the basic process steps for building and distributing a TDP do not need to change (Figure 2). However, the software tools required to view a TDP, specifically a 3D PDF file, will be different (i.e., Abode Acrobat or Adobe Reader in lieu of ImageView). In addition, some minor changes to the execution procedures and development of new solicitation and contract clauses referencing or identifying the 3D PDF file as the technical documentation of record will be required.

For 3D PDF formats, the PDSs and PSs will need to use Adobe Acrobat or Adobe Reader to access and view the files. One of these programs is already installed on every DLA computer and the vast majority of PDS and PS personnel already know how to use them, so there will be little or no training required to open and navigate a 3D PDF (it follows the standard rules for all PDF documents). However, the 3D PDF file differs from a standard PDF file because the interactive 3D model is embedded in the 2D page, which allows the reader to manipulate (rotate and query) the model.

Most of DLA's suppliers already use Adobe Acrobat or Adobe Reader for viewing solicitations and the associated TDPs, so accessing 3D PDF files should not be an issue. Suppliers who do not have Adobe Acrobat or Adobe Reader can obtain copies free by downloading them from the Internet. Suppliers who prefer to use 2D drawings in their manufacturing processes and facilities can print copies of all standard 2D drawing views (e.g., top, bottom, side, and front views) directly from the 3D PDF file.

Model-Based Technical Data

As noted earlier, the services' ESAs are responsible for providing DLA with validated technical data for the parts under their purview. Typically such data comes in a 2D format. However, the technical data for this demonstration must be supplied in a 3D PDF format with an associated STEP file. To learn more about the use of 3D PDF files, we visited three ESAs that use those files for their internal processes: Naval Air Warfare Center (NAWC) Lakehurst; U.S. Army Armament Research, Development and Engineering Center (ARDEC), Picatinny Arsenal; and ARDEC Rock Island Arsenal.

We found all three ESAs are heavily invested in exploring and using the 3D PDF process, and have developed a 3D PDF template for converting 3D models. They have concluded, independent of this effort and similar to STP 4-06, that the 3D

PDF files are the best (currently available) approach for easily transferring and sharing 3D technical data among their own organic industrial shops. We also found that each ESA was very interested and willing to participate in the 3D PDF demonstration because it is the next logical step in their 3D PDF development process—using 3D PDF files to transfer technical data outside their organization to procure a part.

Each of these ESAs has approved internal processes for converting 2D data to 3D models, validating technical data, and supplying that data to DLA. The ESAs noted that they would continue to use those same processes for the demonstration. The only difference, from DLA's perspective, would be that the data provided will be in a 3D PDF file with an associated STEP file (instead of a 2D format), both of which are fully compatible with DLA's computer systems for storing and transferring data between the organizations.

To produce the requisite files for the demonstration, the ESAs will begin with the native computer-aided design (CAD) file and use their PDF conversion software to extract the relevant model information and metadata. (If a CAD file or model does not exist for a part of interest, the ESAs agreed to create one for the demonstration.) The conversion software will insert specific data into an output file based on the ESA's 3D PDF template, which is the 3D equivalent of the 2D drawing format used at each ESA. The template defines the exact data elements, information, and metadata, including dimensions, datum, and tolerances, to be included and their specific location within the 3D PDF file and visual display. The output PDF file will then be reviewed and validated by the ESA as an approved representation of the original model and serve as the data of record for the part or assembly. Subsequently, the ESA will use the same native CAD file to produce the associated STEP file, which will be provided along with the 3D PDF file. The STEP file will contain geometry to create machine code for computer numerical control (CNC) manufacturing. The combined 3D PDF and STEP files will include all of the information necessary for suppliers to manufacture a part irrespective of which CAD or computer-aided manufacturing (CAM) software package they may be using.

Figure 3, 4, and 5 show sample 3D PDF files built using the conversion software and templates developed by the ESAs. Figure 3 and 4 depict the NAWC Lakehurst template that uses a two-page format, while Figure 5 portrays the ARDEC template that uses a one page format. (Note: Picatinny Arsenal and Rock Island Arsenal use the same format as ARDEC.)

Figure 3. Lakehurst Sample Template (Page One)

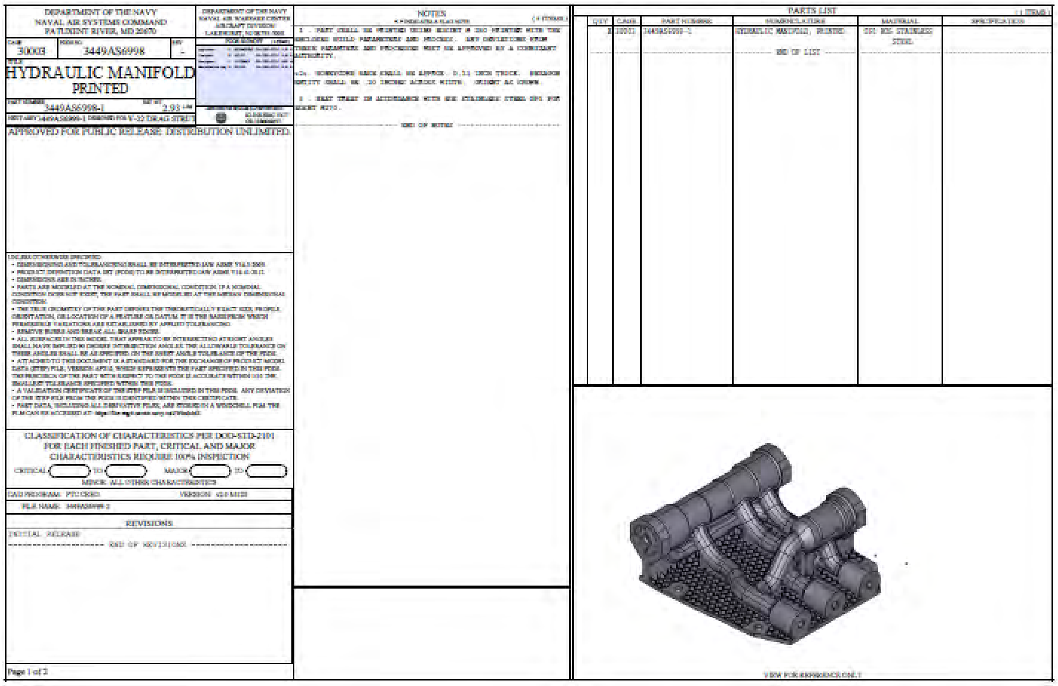


Figure 4. Lakehurst Sample Template (Page Two)

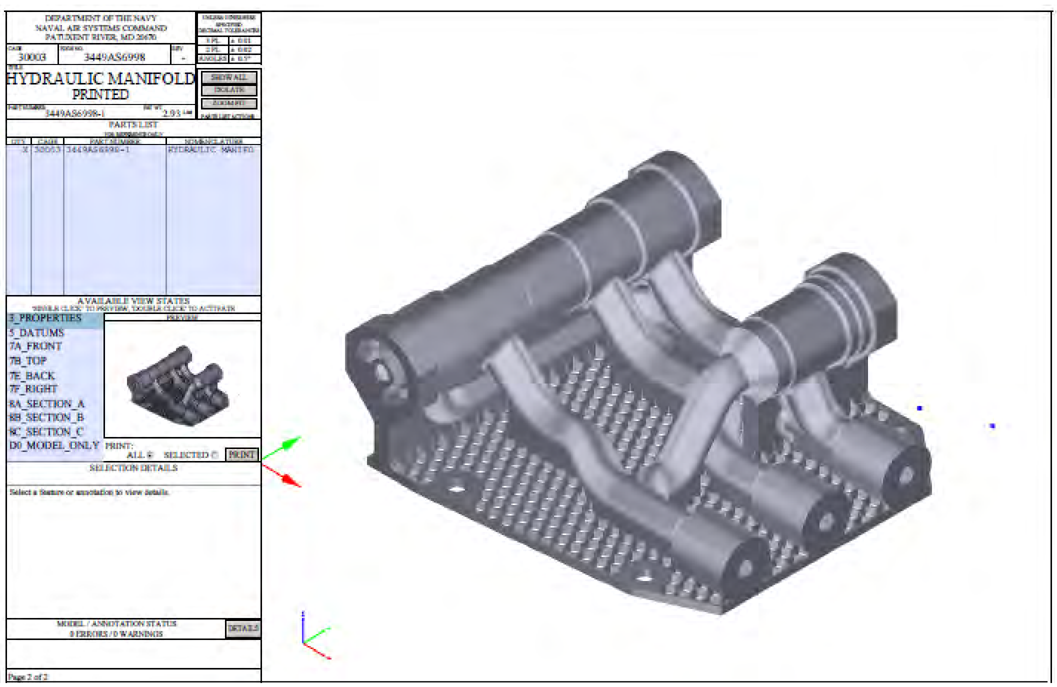
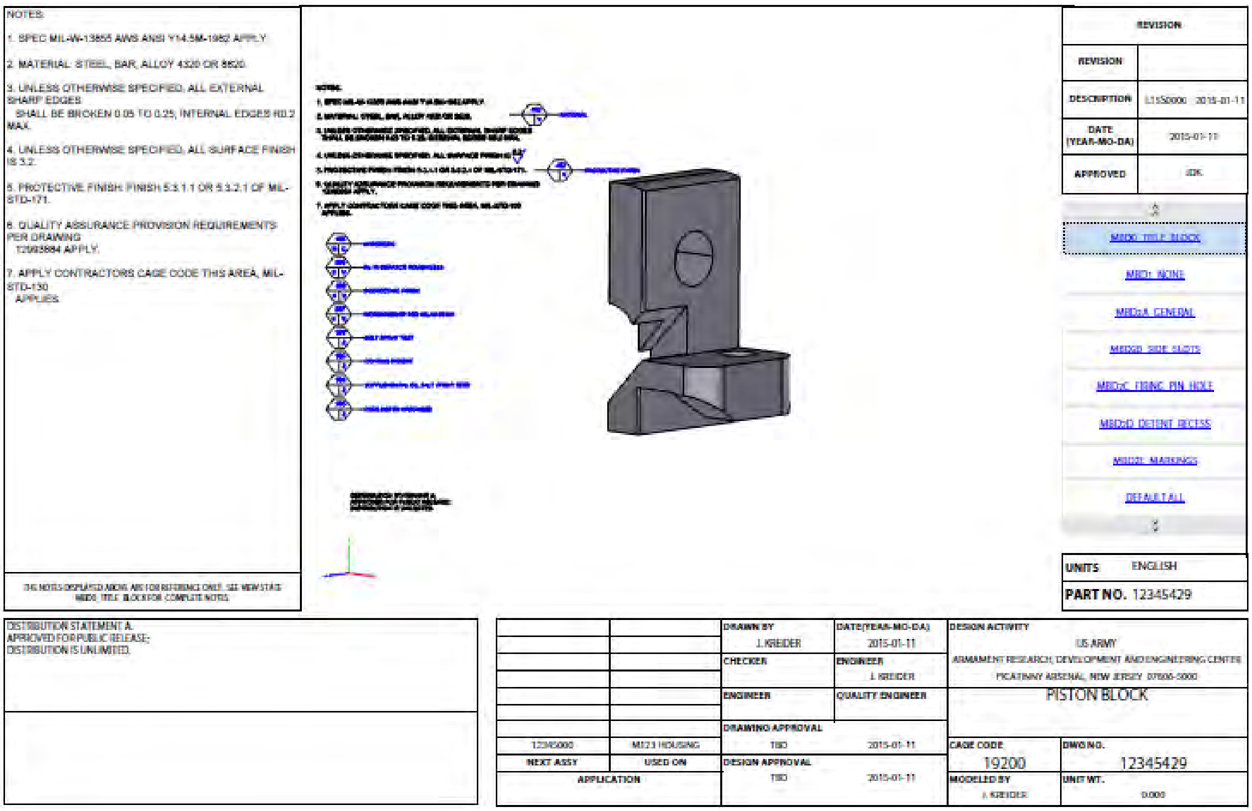


Figure 5. Rock Island and Picatinny Sample Template

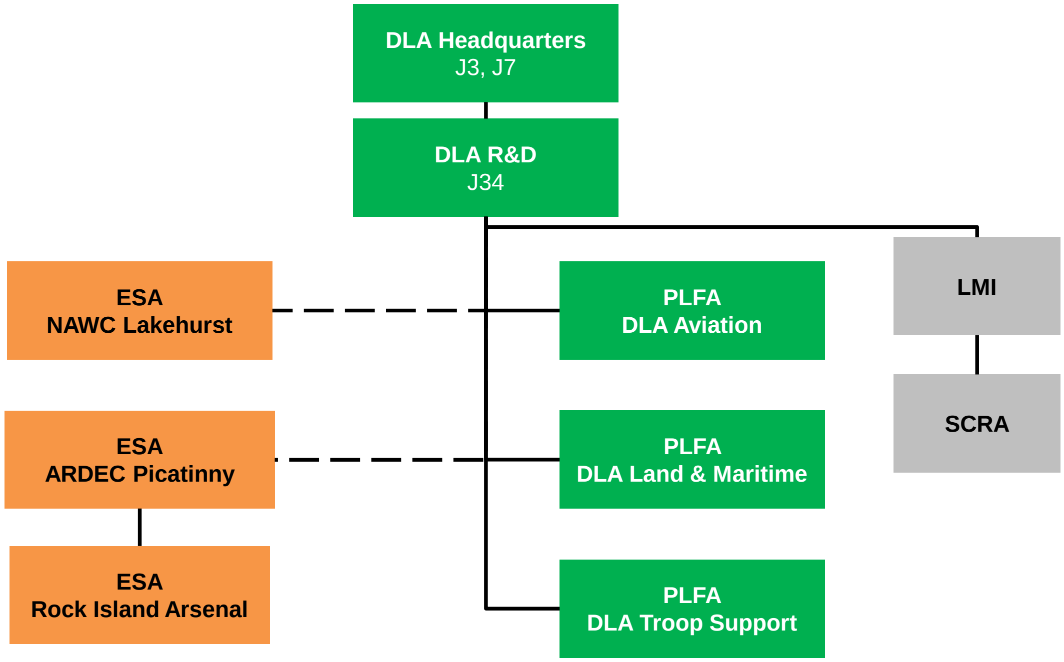


We provided copies of the files in these figures and two other 3D PDF files to product data subject matter experts (SMEs) at three of DLA's primary-level field activities (PLFAs). We asked the SMEs to review each file for ease of use, navigation, and completeness of the specific data elements that DLA requires for procurement. All the SMEs found the files easy to manipulate and interpret, and intuitive to navigate; they had no software or hardware issues associated with loading or reading the files. The SMEs also found no omissions of the requisite procurement data.

3D PDF Demonstration Team

The demonstration team included representatives from several activities within DLA, the military services, and R&D contractors (see Figure 6). A brief description of the roles and responsibilities, workflow, and division of labor among these representatives is provided in the following subsections.

Figure 6. 3D PDF Demonstration Team



Because the objective of this R&D project is to test the existing processes and assess the ability to use only 3D data to procure a part, the DLA and ESA roles and responsibilities for the 3D PDF Demonstration are unchanged from those in use as part of the current procurement process.

DLA Headquarters

Within DLA Headquarters, the principal executive sponsors for the 3D PDF demonstration are J3 (Logistics Operations) and J7 (Acquisition). These organizations establish policy for supply chain management and procurement operations across DLA. Any changes to DLA policy or procedures relative to using 3D TDPs will require J3 and J7 review and approval. J344 (Technical and Quality Assurance) is the principal customer for the 3D PDF demonstration and responsible for reviewing and approving all R&D task recommendations. J344 is also responsible for identifying points of contact within DLA and assisting the R&D contractors in engaging the PLFAs and ESAs.

DLA R&D

The 3D PDF demonstration project is being conducted as part of DLA's WSSP, under the auspices of the J34 R&D community. The J34 R&D project manager for this activity provides funding, day-to-day project oversight, and guidance for the contractors supporting the project. The project manager, in conjunction with the customer (J334), is also responsible for all decisions regarding task continuation at specific project milestones and providing access to key DLA personnel. The project manager is further responsible for coordinating with and informing

other R&D projects and related focus groups about task findings, lessons learned, and recommendations.

DLA PLFAs

Three major supply chains are participating in the 3D PDF Demonstration: Aviation (AVTN); Land and Maritime (L&M); and Troop Support (TS). The supply chains are represented by personnel at the PLFAs in Richmond, Virginia; Columbus, Ohio; and Philadelphia, Pennsylvania, respectively. We briefed the staffs at each PLFA on the objectives, scope, and proposed approach for the 3D PDF demonstration. Each PLFA identified a command point of contact (POC) and agreed to designate specific participants for the follow-on phases of the demonstration after the selection of parts to be procured was approved.

During Phase 1 of the demonstration, PLFA personnel identified the requisite data elements and parts required by DLA for inclusion in a solicitation TDP. They also reviewed sample 3D PDF files (based on the ESA templates) for completeness and ease of use, and assisted in identifying, reviewing, and endorsing candidate parts for possible procurement during the demonstration and for obtaining and providing associated technical data stored in DMS.

During Phase 2 and 3 of the demonstration, PLFA personnel (such as acquisition experts, contracting officers, PDSs, and PSs) will be directly responsible for procuring selected parts using the 3D PDF and STEP files following the procedures previously described in the Current Procurement Process section of this report.

ESAs

All three ESAs participating in the 3D PDF demonstration—NAWC Lakehurst, ARDEC Picatinny Arsenal, and ARDEC Rock Island Arsenal—are using 3D PDF files and have working relationships with one or more of the three DLA PLFAs participating in the demonstration.

During Phase 1 of the demonstration, ESA personnel provided sample 3D PDF files for PLFA SME review and subsequent comparison with the list of DLA data elements required for a procurement. They also updated their 3D PDF templates to accommodate any issues or deficiencies found by the PLFA SMEs. Additionally, ESA personnel assisted in identifying candidate parts for PLFA review and possible procurement during the follow-on phases of the demonstration.

During Phases 2 and 3 of the demonstration, ESA personnel will develop and validate a 3D PDF file and associated STEP file for each part selected for procurement. The ESAs will transfer these files to the appropriate PLFAs using their standard procedures and processes. The ESAs will provide support to the PLFAs as necessary during the procurement by responding to any technical questions related to the parts being procured. After the parts have been manufactured, ESAs

will validate each delivered part against the 3D PDF file (data of record) and submit summary reports of their findings to the appropriate PLFAs.

R&D Contractor Team

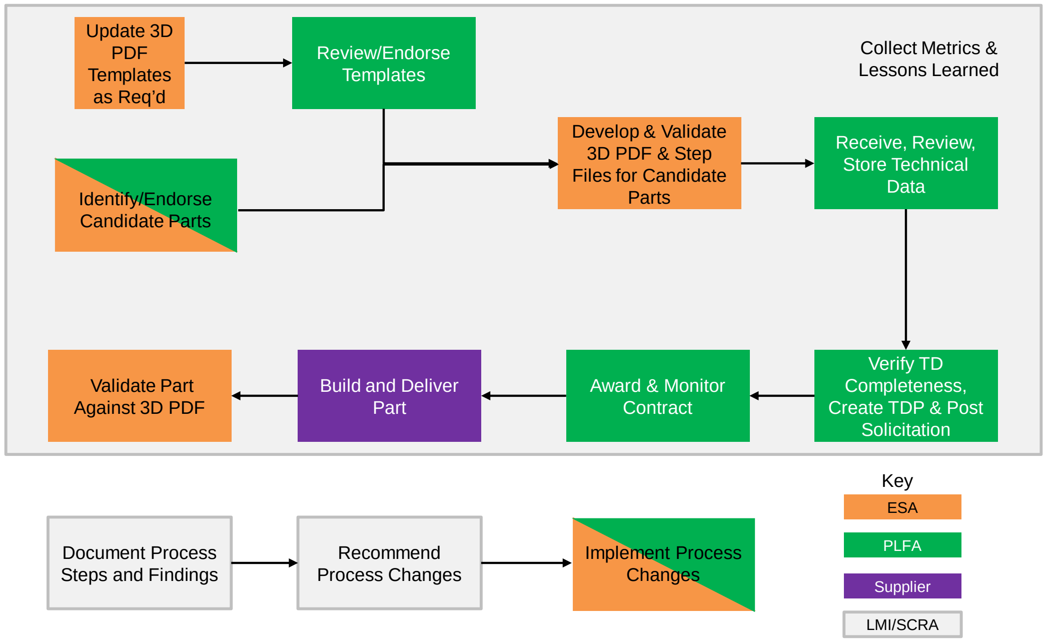
A team of contractor personnel from LMI and SCRA are responsible for the development and performance of STP 4-06 3D PDF demonstration, under the auspices of the Research and Development for DLA Supply Support (RDSS) II contract.

During Phase 1, the contractor team (LMI and SCRA) built support for the demonstration at the PLFAs and ESAs, characterizing the current DLA procurement process and identifying necessary changes to facilitate use of 3D data. The team evaluated and confirmed that the ESA model-based technical data development and transfer processes were sufficient to create and use the 3D PDF files, identified participating organizations for the demonstration, defined and established participant roles and responsibilities, and coordinated the transfer and review of sample 3D PDF files and PLFA endorsements of the ESA 3D PDF templates. The team also developed a set of criteria for identifying candidate parts and coordinated the selection and consolidation of those parts for procurement during the next phase of the 3D PDF Tech Data Demonstration. Finally, the team coordinated the development of metrics to be collected during the actual procurement process in the follow-on phases.

During Phases 2 and 3 of the demonstration, the contractor team will assist the PLFAs in selecting the final candidate parts for procurement and coordinating development of the associated 3D PDF and STEP files by the ESAs. The contractor team will also monitor the actual procurements and collect and document metrics, lessons learned, and any changes made to the procurement process to accommodate the use of 3D technical data. It will further document the findings and conclusions from each phase of the demonstration, including validation of parts against the 3D PDF data of record and make recommendations to DLA and the ESAs regarding process changes.

Figure 7 illustrates the basic workflow activities and the responsible organization for the 3D PDF Demonstration as described in the preceding subsections.

Figure 7. 3D PDF Demonstration Workflow and Responsible Organization



DLA Candidate Parts

The key step in the 3D PDF demonstration is the procurement and manufacture of actual parts using only a 3D PDF file and associated STEP file as the technical data of record. Accordingly, a select number of parts were identified as potential candidates for procurement and manufacture during the follow-on phases of the demonstration. They were selected based on the following criteria:

- DLA-managed, Class IX part
- Not a sole source part
- Not currently identified as a “problematic part” for technical or logistics reasons
- Simple to medium manufacturing complexity
- Less than $3,000 unit cost
- Complete and current technical data package available:
  - 2D drawing required as a minimum
  - 3D model preferred, but not required
  - 3D PDF file preferred, but not required.

The selection criteria were provided to the ESAs and PLFAs for identifying the parts that best satisfied the criteria. Based on the selection criteria, the ESAs and PLFAs prepared lists of parts for consideration and consolidation. The lists were reviewed and sorted to ensure that each candidate part was managed by one of the participating PLFAs (AVTN, L&M, or TS) and fell under the technical cognizance of one of the participating ESAs (Lakehurst, Picatinny, or Rock Island). The final list of candidate parts is presented in Tables 1 through 5, broken out by cognizant ESA and managing PLFA.

Table 1. Candidate Parts for Rock Island and L&M

FSC	NIINs	Nomenclature	ESA	PLFA
1010	001813413	Sear M203	Rock Island	L&M
1005	005504081	M2 Cover, Sub Assembly	Rock Island	L&M
1005	005504060	M2 Latch Bolt	Rock Island	L&M
1005	005504094	M2 Sleeve, Buffer Tube	Rock Island	L&M
1005	009182618	M2 Plate, Back	Rock Island	L&M
1005	006261110	M2 Slide Assembly, Belt	Rock Island	L&M
5315	006008919	M2 Pin, Eccentric	Rock Island	L&M
105	006573953	M2 Slide Assy, Retracting	Rock Island	L&M
1005	010328142	Plunger, Extractor	Rock Island	L&M
1005	015107226	M19 Support Assembly	Rock Island	L&M
1005	015441698	Blank Firing Chamber	Rock Island	L&M
1095	011977902	Storage Rack	Rock Island	L&M
1005	010054494	Unlocking Cam Kit	Rock Island	L&M

Table 2. Candidate Parts for Lakehurst and AVTN

FSC	NIINs	Nomenclature	ESA	PLFA
5342	005641857	Fairlead Section, Block	Lakehurst	AVTN
3130	009483551	Bearing Unit, Roller	Lakehurst	AVTN

Table 3. Candidate Parts for Lakehurst and L&M

FSC	NIINs	Nomenclature	ESA	PLFA
1710	014830682	Bushing Retainer	Lakehurst	L&M
1710	015752641	Pole Base Sighting	Lakehurst	L&M

Table 4. Candidate Parts for Lakehurst and TS

FSC	NIINs	Nomenclature	ESA	PLFA
5315	013909100	Straight Threaded pin	Lakehurst	TS
5340	016084916	Cable Sheave Guide	Lakehurst	TS
5306	016087883	Bolt Clevis	Lakehurst	TS
5340	015042416	Rod End Locking Retainer	Lakehurst	TS
5306	015046790	Shoulder Bolt	Lakehurst	TS
5305	015752645	Shoulder Screw	Lakehurst	TS
5340	013905852	Loop Clamp	Lakehurst	TS

Table 5. Candidate Parts for Picatinny and AVTN

FSC	NIINs	Nomenclature	ESA	PLFA
3110	014982098	Plate, Retaining, Bearing	Picatinny	AVTN
3110	016065377	Catcher Ring, Outer	Picatinny	AVTN
6680	010792957	Tachometer, Brushless	Picatinny	AVTN
6610	014787509	Tray Assembly	Picatinny	AVTN
3110	016065371	Catcher Ring, Inner	Picatinny	AVTN

The candidate parts will be reviewed at the beginning of the follow-on phases of the demonstration to select the specific parts to be procured in Phases 2 and 3 using only 3D PDF technical data. Current planning for these phases calls for the procurement of two different parts during each phase by each PLFA.

Metrics

During the follow-on phases, the demonstration team will collect data for assessing the procurement process using only 3D PDF and STEP files as the technical data of record. Listed below are some of the specific metrics identified during Phase 1 of the demonstration:

- ESA ease in transferring 3D PDF and STEP file technical data packages to DLA
- Time to develop a solicitation with a 3D PDF and STEP file technical data package (DLA)
- PLFA ease in using 3D PDF technical data to develop a solicitation
- Number of questions from suppliers (contractors) regarding technical content of the TDP during pre-award

- Contractor ease in using 3D PDF technical data during pre-award
- Time to develop a bid (contractor)
- Cost to develop a bid (contractor)
- Time to award a contract (DLA)
- Number of questions from contractors regarding technical content of the TDP after contract award
- Contractor ease in using 3D PDF technical data during post award and manufacturing
- Time to manufacture an item (contractor)
- Cost to manufacture an item (contractor)
- Number of delivered parts deemed compliant when validated against the 3D PDF data of record.

The list of metrics will be reviewed at the beginning of each of the follow-on phases to identify additions, changes, and deletions. The demonstration team will gather, assess, and document the resulting metrics.

Appendix A. Legacy Data Modernization

In modernizing its technical data, DLA needs to understand when it is beneficial, whether from a financial or support perspective, to convert 2D technical data to a 3D model or 2D PDF format. This appendix summarizes the legacy data conversion findings collected during the broader STP 4-06 task.

Which Legacy Data Should Be Modernized?

DLA holds millions of pieces of legacy technical data in DMS. Although converting all of those data to a more modern format would be cost prohibitive, some legacy data should be converted. In deciding which data to convert, DLA should evaluate various types of technical and business information, such as the following:

- Data rights
  - Who owns the technical data (government or contractor)?
  - What are the government's rights (limited, unlimited, or none)?
- Part complexity and technology state in the manufacturing sector
  - How much 3D data are required (simple versus complex parts)?
  - What is the manufacturing sector automation level and use of 3D data?
- Forecasted demand and stock on hand
  - What is the anticipated number of parts to be procured per unit time?
  - Is there sufficient on-hand stock to meet future needs?
  - What is the anticipated service life of the part or associated weapon system?
- Potential cost savings from competition
  - Is this a sole source item (savings may not materialize because of a lack of competition)?
  - Are there multiple sources for manufacturing the part?
  - Will more suppliers bid because the technical data are available in 3D format?

- Potential time savings
  - Will delays due to technical data legibility issues decrease?
  - Will part rework decrease because of reduced instances of suppliers misinterpreting technical data?
- Cost to convert data
  - How much will it cost to convert the data to a more modern format?
  - What is the timeframe for recovering the conversion investment?
  - What is the cost to validate and verify the converted technical data?
  - What additional costs will be incurred to validate parts manufactured using the modernized technical data?

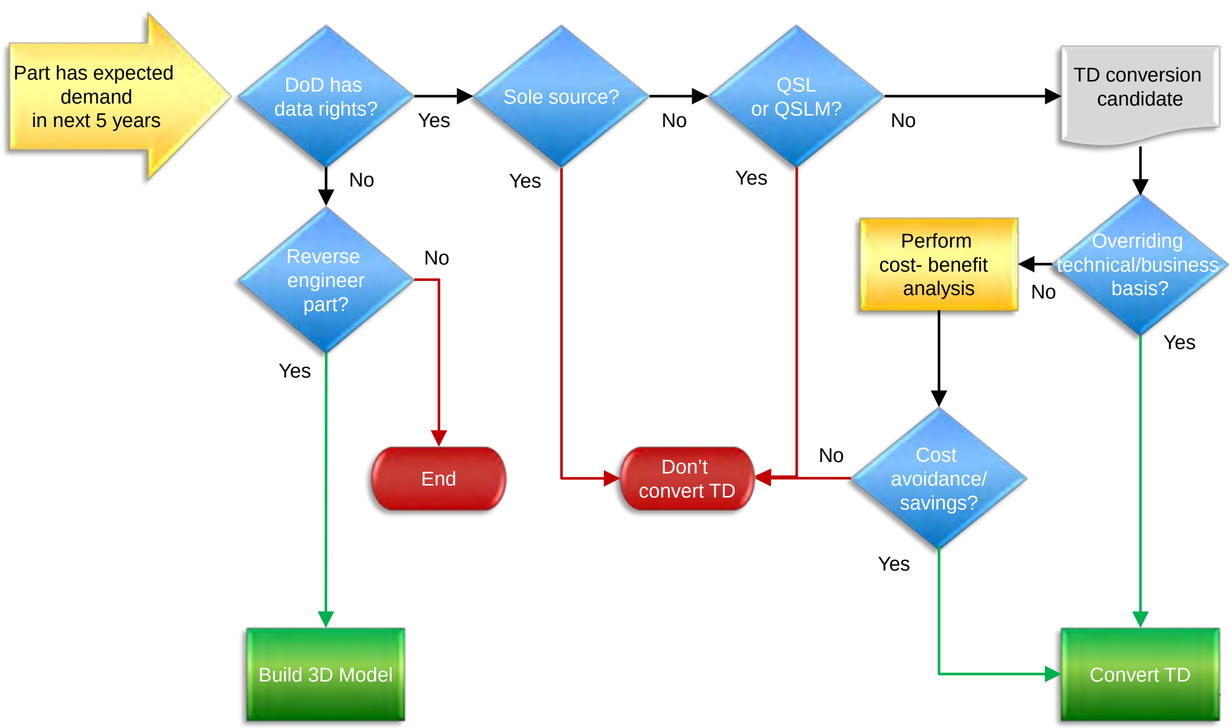
This information would enable DLA to apply a pragmatic approach to identifying the best candidates for technical data conversion. That approach could include categorizing parts into one of the following:

- Format conversion is self-evident
  - The part was designed or built by an original equipment manufacturer using a CAD or CAM process, so a 3D model already exists.
  - The DoD or DLA mandates an additive manufacturing (AM) capability for a part, which requires a 3D model.
  - The existing technical data is physically deteriorating, so it needs to be copied or recreated using modern processes.
  - The part needs to be reverse engineered, which means it will be redesigned using a CAD process to create a 3D model.
  - Upgraded or converted technical data are available at no charge from a manufacturer fulfilling a DLA contract.
- Format conversion is a natural byproduct of a weapon system modification or product upgrade
  - An engineering change to an existing part means that the technical data was redesigned using a CAD system.
  - A revised or updated version of the 3D technical data exists.

- Format conversion will facilitate substantive technical quality improvements
  - The conversion will preclude product quality issues that stem from technical data problems, such as illegible drawings, or missing or ambiguous design details.
  - The conversion will mitigate pre-award or post-award supplier or contract issues related to comprehensiveness, legibility, or clarity of the technical data.
- Format conversion is potentially advantageous to DLA and DoD
  - The conversion will shorten administrative lead time (ALT) or procurement lead time (PLT) by reducing manufacturer response or preparation time.
  - The conversion will lower item cost by attracting new manufacturers, which will increase competition.
  - Upgraded or converted technical data will be available at minimal charge from a manufacturer fulfilling a DLA contract.

After categorizing the part, DLA could apply a decision tree, such as the one depicted in Figure A-1, to determine specific technical data that should be converted.

Figure A-1. Legacy Technical Data Modernization Decision Tree



Below we expand on each of the major decision blocks in the decision tree in Figure A-1:

- *Part has expected demand in next 5 years.* Because of the associated cost, DoD should only modernize parts that are likely to be procured in the near future.
- *DoD has data rights?* If DoD does not hold appropriate data rights for a part, it cannot provide the technical data to suppliers or manufacturers for use in building a part nor can it modify or convert existing data without permission. Obtaining data rights after the fact is generally a costly proposition, one that DoD rarely exercises.
- *Reverse engineer part?* When no technical data exists or the original supplier (owner) of the data rights is no longer in business. DoD may be able to recreate the data by reverse engineering an existing part. Since most engineering design today is performed using CAD processes, all technical data created during the reverse engineering process would be a modern 3D model. If reverse engineering is not a viable option, then no technical data will be created.
- *Sole source?* If the part can only be produced by a single manufacturer, DoD would have no reason to convert the technical data. The manufacturer would already have all necessary data and, most likely, a 3D model.
- *QSL or QSLM?* If the part can only be produced or provided by an entity included on a qualified supplier list (QSL) or qualified supplier list of manufacturers (QSLM), DoD has no reason to convert the technical data because the entity already has the data, and, most likely, a 3D model.
- *TD conversion candidate.* All parts that have an expected demand, DoD has data rights, and are not sole source, or subject to a QSL or QSLM are potential candidates for technical data modernization.
- *Overriding technical/business basis?* All parts categorized as "format conversion is self-evident" or "format conversion is a natural byproduct of weapon system modifications or product upgrades" are considered to have an overriding basis for conversion because any new technical data will already be in a modern format. All other parts should be subjected to a cost-benefit analysis.
- *Perform cost-benefit analysis*. Any cost-benefit analysis should consider the following: 5-year demand forecast; part cost; cost to convert legacy data to a new format; cost to validate the data in the new format; expected reduction in ALT or PLT resulting from use of the modernized format; expected reduction in pre-award and post-award administration resulting from use of the modernized format (e.g., fewer supplier questions regarding TDPs); and expected savings from reduced technical or quality issues

(i.e., Product Quality Deficiency Reports [PQDRs]) associated with parts made using the modernized data.

- *Cost avoidance/savings?* DoD should convert all candidate parts when the total cost to convert existing technical data to a modern format is less than the projected savings (or avoided costs) from using the modern data.

Conversion Costs

The cost to convert legacy technical data to a modern 3D format is directly related to part complexity and the number of 2D drawing pages associated with the part. This section shows some time estimates for converting 2D data based on part complexity. DLA can calculate the conversion costs by multiplying the conversion time by an estimated hourly labor rate. For presentation purposes, we broke out the parts into simple, medium, and complex categories:

- Simple part (1 to 3 hours to convert)
  - 1-page drawing of a basic part (e.g., shaft, washer, or handle)
  - Drawing contains few dimensions, few geometric dimensioning and tolerancing (GD&T) requirements, minimal notes
- Medium part (4 to 8 hours to convert)
  - 2- or 3-page drawings of a piece part or a simple assembly with several parts
  - Drawing contains moderate amount of dimensions along with some GD&T, and a couple of section views
- Complex part (12 to 40 hours or longer to convert)
  - 4- to 10-page drawings of piece part or an assembly with many parts
  - Drawing contains numerous dimensions, full GD&T, many notes, all technical specifications spelled out on the drawing, and multiple section views.

Converting 2D legacy data to a more modern 2D PDF format is a relatively simple process that can be performed in a few minutes. However, prior to conversion, the source file or legacy data may need to be cleaned up (such as de-speckled or de-skewed), and the time to perform any clean-up will vary depending upon the age and legibility of the source file.

Conversion Formats

DLA currently uses a variety of 2D legacy data formats, such as raster files in .jpg, .gif, .png, or .tif formats, Gerber files, and Mylar. However, most of the legacy files are in a C4 format that requires a special viewer (ImageView). As a consequence, the most appropriate modern format conversions for these files are either 2D PDF files or 3D native files developed using either Solidworks, CREO, NX, or CATIA CAD software.

The selection of a modern 2D or 3D format depends on several factors, including whether a 3D model exists from the legacy 2D data; the reason for the conversion (e.g., physical deterioration data, illegible data, or ambiguous design intent); the cost to convert to a modern format; and the predicted cost benefits of the conversion. For the 3D file conversions, the specific format will depend on the CAD software used to produce the original native file or the CAD software in use at the service program office or ESA that owns the technical data.

If the modernized format is a 3D model, the model will need to be converted to a 3D PDF file for use in procurement actions. Such conversions should be performed by the service program office or ESA that owns the technical data because that office will ultimately be responsible for validating the 3D PDF file against the native file format.

Modernization Approach

DoD has three basic approaches for modernizing its legacy technical data:

1. *Perform all modernizations or conversions in-house*. Under this approach, the service program office or ESA owning the technical data would modernize the data; it would also be responsible for validating the modernized data against the legacy data.

2. *Hire a third-party vendor to perform the modernizations or conversions*. Under this approach, the service program office or ESA that owns the technical data would still need to validate the modernized data against the legacy data.

3. *Require a supplier or manufacturer to provide a copy of the 3D model (in a native file format) used in producing the item as part of a procurement delivery*. Most manufacturing operations today use CNC systems, which require machine codes derived from 3D models. Again, the service program office or ESA that owns the technical data would be responsible for validating the modernized data against the legacy data.

In all cases where the modernized format is a 3D model, the model would need to be converted to a 3D PDF file for use in procurement actions. Such conversions should be performed by the service program office or ESA that owns the technical data because it would ultimately be responsible for validating the 3D PDF file against the native file format.

When Should Technical Data be Modernized?

DLA has the following options for scheduling or performing technical data modernizations:

- Before a procurement
  - Timing based on next "predicted" buy
  - Timing based on a DLA-specified schedule independent of next 'predicted' buy.
- During a procurement
  - As part of the TDP build process, although this option could significantly impede the TDP and solicitation build process, which will negatively affect ALT
  - As part of the supplier's part production, where the supplier is required to deliver a 3D model as part of the procurement.

ESA and PLFA Thoughts Regarding Legacy Data Conversion

We solicited input regarding legacy data conversion from the ESAs and PLFSs participating in the 3D PDF Demonstration. Their responses are summarized below to provide DLA context for developing its approach to modernizing legacy data.

PICATINNY ARSENAL

"There are three scenarios we see as a policy for [Army Material Command (AMC)] to follow regarding digitizing TDPs.

- [Option 1] Digitize everything we have. This is prohibitively expensive and overkill considering a lot of TDPs are obsolete or see little use.
- [Option 2] Digitize as needed for reset programs and sustainment. This option is less expensive and is driven by the sustainment side of the acquisition system. As systems are provided new packages and upgrades, the needed tech data would be in 3D format.
- [Option 3] Digitize for new acquisitions and programs. This would be the lowest cost option to the enterprise. As new programs are initiated they

would be required to build 3D TDPs from the start. All legacy systems would remain as-is.

We envision the best course of action is to combine Options 2 and 3. The decision to go 3D for a TDP would probably still be made on a case-by-case basis. There is still a question of who would pay for these conversions. We would like to see some help from the AMC level."

Rock Island Arsenal

"We feel [that] when converting from a 2D drawing to a 3D model there are several considerations to take into account. Such as:

- Is the TDP active and are we buying to it?
- Is the TDP being used for purchase of end items, or being used only for spare parts?
- Is there enough qualified people in-house capable of doing the conversion work, or will it have to be contracted out?
- Cost of converting?
- Is there a cost savings associated with the conversion effort?

The decision to convert a TDP from 2D to 3D is left to the affected [program management office]. Many of the considerations outlined above will come into play when making a decision to convert."

NAWC Lakehurst

"We believe that the primary benefit of [a model based design (MBD)] TDP is in the initial interpretation of the data package and the associated set up costs in manufacturing. If a 2D TDP already exists and is having parts manufactured to it, any benefit of a new 3D TDP would be limited. There could be benefits beyond MBD of [having] 3D models existing in a [product lifecycle management] environment which could lead to lower life cycle costs. However, this benefit would be outside of MBD, but rather other benefits realized through life-cycle management."

PLFA, Richmond

"We feel that DLA will have the majority of influence in determining what will be converted. The ESAs will only be concerned with their ability to review and approve 3D conversion data once DLA decides to pursue it. We feel that the simple items will not need conversion by DLA. Those items are already converted to 3D very quickly and efficiently by the manufacturers. Items that have more complex geometries will be the best candidates, particularly those with complex curves or internal features. Demand forecast for each item will also be important.

Items that are procured infrequently will not be the best candidates since payback for our conversion efforts may not be realized. Limited source items are also not good candidates since the manufacturers likely already have the 3D. In the end, fully competitive items with regular, recurring demand and more complex features appear to be the best candidates for conversion."

"In terms of converting a 2D drawing to a 3D model, we do this when the 2D drawing is incomplete, which requires the need to reverse engineer the part. [Once the reverse engineering 3D model is built, we] actually convert back to a 2D drawing because that is what the ESA's are used to seeing, and what DLA has been using on solicitations. Other than that, [the reverse engineering] team has no need to convert 2D drawings to 3D models."

PLFA, Columbus

"DLA making a unilateral decision to convert 2D data to a 3D model, would be rare. There are foreseeable benefits for diminishing manufacturing source and hard to procure items, as well as items that can be procured using 3D printer technology. However, until we have some hard facts, it's hard to say 'what's in it for DLA?'"

If DLA was funding the conversion, it would mostly be based on the following:

- Is industry asking that it be converted?
- Is the part so complex that it needs to be converted?
- Does the annual demand value/annual demand frequency for the item warrant conversion?
- Is there a need to convert for reverse engineering purposes?"

PLFA, Philadelphia

"Conversion could be focused on items that have a high demand or the current TD has issues causing the manufacturing issues in producing the part. Focusing on items where the manufacturing base is already widely using 3D data including 3D PDF.

There is little value in creating a 3D model or a 3D PDF for an item that we regularly purchase from the same small pool of vendors. If we have solid regular sources of supply for an item the vendor base is not really loading any drawings, we are simply ordering by number. The best items to start with would be items with complicated geometrics that are being broken out from sole source to fully competitive." w

Appendix B. Technical Data Checklist

We interviewed numerous personnel who use technical data in their daily activities at each of the DLA supply chains—Troop Support, Land and Maritime, and Aviation. We asked them to identify some of the specific information and information attributes that PDSs and PSs review and use when building a TDP for a procurement bidset. Some of their responses are listed below:

- Legibility
- Completeness
- Restrictions
- Document approval
- Document title
- Document number
- Revision and date
- Revision type
- Expiration date
- Document data code
- Size of drawing, number of sheets, and frames
- Call outs
- Sources
- First article test requirements
- Inspection requirements
- Higher level contract quality requirements
- Part number
- National stock number
- Export control
- Commercial and government entity code
- Specifications

- Dimensions
- Tolerances
- Welding requirements
- Materials (ballistics)
- Temper
- Heat treatments
- Finishes
- Rights in data
- License agreement
- Distribution statement
- Document type, such as parts lists, detailed drawings, and quality assurance provisions
- Security code
- Technical data availability code
- Foreign secure
- Nuclear
- SUBSAFE
- Control code.

APPENDIX C. ABBREVIATIONS

2D	two-dimensional
3D	three-dimensional
ALT	administrative lead time
AMC	Army Materiel Command
ARDEC	U.S. Army Armament Research, Development and Engineering Center
CAD	computer-aided design
CAM	computer-aided manufacturing
CNC	computer numerical control
CONOP	concept of operations
DIBBS	DLA Internet Bid Board System
DLA	Defense Logistics Agency
DMS	Document Management System
EDL	engineering data list
ESA	engineering support activity
GD&T	geometric dimensioning and tolerancing
MEDALS	Military Engineering Data Asset Locator System
MBD	model based design
OSD	Office of the Secretary of Defense
PDF	portable document format
PDS	product data specialist
PLFA	primary-level field activity
PLT	procurement lead time
PQDR	product quality deficiency report
PS	product specialist
R&D	research and development
SME	subject matter expert
STEP	Standard for the Exchange of Product Model Data (ISO 10303)
TDP	technical data package
TDPL	technical data package list
TQ	technical and quality

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The goal of the 3D PDF technical data demonstration (an adjunct R&D task under STP 4-06, Model-Based Technical Data in Procurement) is to help DLA move toward the use of more modern technical data in its daily procurement activities and influence DoD to adopt 3D PDF data files as a means of transferring those data. The use of modern 3D data would give DLA a more agile, more reliable, and less costly way to have parts built to support America's warfighters.
The project's objective is to assess DLA's capability to acquire Class IX parts using modern technical data recorded in a 3D PDF file with an attached STEP file. To accomplish this objective, the demonstration will exercise DLA's current procurement process to buy real parts in an operational environment. Phase 1 of the project, which is the focus of this report, concentrates on establishing the groundwork and performing the planning actions for parts procurement during the follow-on phases of the 3D PDF technical data demonstration.

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